



**UNIVERSITI PUTRA MALAYSIA**

**RESOLVING SPATIAL CONFLICTS IN COMPUTER-GENERATED  
COLLISION DIAGRAMS FOR ROAD ACCIDENT ANALYSIS**

**AHMAD RODZI MAHMUD**

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**RESOLVING SPATIAL CONFLICTS IN COMPUTER-GENERATED  
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**By**

**AHMAD RODZI MAHMUD**

**Thesis Submitted to the School of Graduate Studies, Universiti  
Putra Malaysia, in Fulfilment of the Requirement for the  
Degree of Doctor of Philosophy**

**October 2002**



*Dedicated to my wife, Kausar, Khaulah and the rest of the  
families.....*

Abstract of thesis presented to the Senate of Universiti Putra  
Malaysia in fulfillment of the requirement for the degree of  
Doctor of Philosophy

**RESOLVING SPATIAL CONFLICTS IN COMPUTER-GENERATED  
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**October 2002**

**Chairman : Professor Ir. Dr. Radin Umar Radin Sohadi**

**Faculty : Engineering**

This research deals with the depiction of road accident scenes using symbols. When cartographic symbols are presented, there may be situations where they are either too close or overlapping. Manual intervention is thus needed to rearrange the symbols to avoid confusing the user. This condition, known as spatial conflict, is part of the problem in cartography especially in the process of automated generalization.

When a collision diagram is drawn to show the road user movements (RUM) that indicate the nature of vehicle maneuver in road accidents at a particular site, the position of the event is often re-located because of the type and size of symbols used. The changes made are always tentative, iterative and subjective. It is



also a time consuming process, as the draughtsman need to decide the right and accurate symbols to be presented. These processes are needed, as the symbols are usually close or overlapping against each other. The diagram may not be much helpful to the traffic engineer if no intervention is being made to re-position the symbols. A clear and informative diagram is necessary to determine the predominant type of road accident, and for proposing the best remedy. Therefore, the procedures in the creation of Collision Diagram involve an iteration process which are subjective due to an array of human factors involved in making decisions. As a result, inaccuracy occurs in presenting the right position and the right symbols. Hence this work focuses on the automation process for resolving the spatial conflict.

The methodology proposed in this work is motivated by several approaches used in arranging objects in the form of circles within a limited space. Instead of plotting in rows, square or hexagons, the methodology implemented introduces some enhancement in geo-computation work to avoid wasting space and at the same time attempts to preserve topological relationships. An algorithm for resolving the spatial conflict in cartographic terms was designed and tested. Implementation of this technique enhances the methodology of creating Collision Diagrams, and maintains the topological relationships between the symbols. The

work undertaken is part of the phases in “knowledge construction process” specifically to solve spatial conflict issues.

The approach taken had enhanced the traditionally solution of re-arranging the position in rows to avoid any overlapping cases. Hence, the study contributes a methodology in resolving spatial conflict in the process of automated generalization. The output of this work is a spatial-conflict removal module written in Pascal. The data for this system is an accident database taken from a format generated by a package known as Micro Accident Analysis Package (MAAP) used by the Royal Police of Malaysia. The system module created from this work will assign a proper symbol for each accident event and will automatically refine its location. The format of the data being generated is in the form of relational database, which is easily transferred for further analysis in the Geographical Information System (GIS) environment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra  
Malaysia sebagai memenuhi keperluan untuk ijazah Doktor  
Falsafah

**MENYELESAIKAN KONFLIK RUANG DALAM RAJAH  
PERLANGGARAN JANAAN-KOMPUTER UNTUK ANALISIS  
KEMALANGAN JALAN RAYA**

Oleh

**AHMAD RODZI MAHMUD**

**Oktober 2002**

**Pengerusi : Profesor Ir. Dr. Radin Umar Radin Sohadi**

**Fakulti : Kejuruteraan**

Penyelidikan ini berurusan dengan penggambaran kemalangan jalan raya melalui kegunaan simbol. Apabila symbol kartografik ini di persembahkan ada kemungkinan pada keadaan tertentu ianya terlalu rapat atau bertindihan. Simbol-simbol ini perlu di susun semula secara manual untuk mengelakkan kekeliruan kepada pengguna peta. Keadaan seperti ini dikenali sebagai perselisihan data ruang. Ia adalah sebahagian dari permasalahan di dalam kartografi terutamanya dalam proses automasi generalisasi.

Apabila rajah perlanggaran di lukis untuk menggambarkan sifat pergerakan kenderaan yang terlibat, lokasi bagi kejadian

tersebut biasanya disesuaikan dengan jenis dan saiz simbol yang tertentu. Perubahan yang dibuat biasanya bersifat sementara, berulang kali dan tidak menentu. Ia juga adalah satu proses yang mengambil masa yang lama kerana pelukis pelan perlu membuat keputusan untuk memilih simbol yang betul dan tepat. Proses ini diperlukan kerana simbol-simbol biasanya terlalu rapat atau bertindihan sesama sendiri. Rajah seperti ini tidak membantu kepada jurutera trafik sekiranya tiada campurtangan dilakukan untuk mengubahsuai kedudukan simbol-simbol tersebut. Satu rajah yang jelas dan bermaklumat adalah perlu bagi menentukan jenis kemalangan paling utama dan seterusnya boleh digunakan untuk mencadangkan cara terbaik memperbaiki permasalahan tersebut. Oleh itu kajian ini di fokuskan untuk menyelesaikan perselisihan data ruang dalam proses automasi generalisasi.

Kaedah yang di utarakan dalam kajian ini di motivasikan melalui pelbagai pendekatan dengan menyusun objek-objek berbentuk bulatan dalam satu ruang yang terhad. Kaedah yang dilaksanakan telah memperkenalkan beberapa peningkatan dalam kerja geo-hitungan untuk mengelakkan pembaziran ruang dan dalam masa yang sama memelihara hubungan topologi sesama objek. Ini adalah pengganti kepada kaedah pemplotan mengikut barisan, segiempat sama dan hexagon.



Pendekatan ini telah mempertingkatkan penyelesaian secara tradisi dimana kedudukan simbol diletak mengikut baris untuk mengelakkan pertindihan. Oleh yang demikian kajian ini telah menyumbang satu kaedah dalam menyelesaikan permasalahan pertindihan data ruang dalam proses automasi generalisasi. Hasil pengeluaran dari kajian ini adalah modul penyingkiran konflik dataruang. Ia telah dibangunkan dalam bahasa pengaturcaraan Pascal. Data untuk sistem ini adalah berpunca dari pangkalan data kemalangan yang diambil dari format yang dikeluarkan oleh Pakej Analisa Mikro Kemalangan Jalan Raya (MAAP). Pakej ini digunakan oleh Polis diRaja Malaysia. Modul sistem yang dibentuk dapat menentukan simbol yang sesuai bagi setiap kes kejadian dan secara automatik akan memberi lokasi yang lebih jelas kedudukannya. Format data yang dihasilkan adalah dalam bentuk pangkalan data berhubungkait di mana dengan mudah boleh dipindahkan untuk analisa lanjut dalam kesekitaran sistem maklumat geografi (GIS).

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Ahmad Rodzi Mahmud

I certify that an Examination Committee met on 17<sup>th</sup> October 2002 to conduct the final examination of Ahmad Rodzi Mahmud on his Doctor of Philosophy thesis entitled "Resolving Spatial Conflicts in Computer-Generated Collision Diagrams for Road Accident Analysis" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

**Abdul Rashid Mohamed Shariff, Ph.D.**

Faculty of Engineering  
Universiti Putra Malaysia  
(Chairman)

**Ir. Radin Umar Radin Sohadi, Ph.D.**

Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

**Shattri Mansor, Ph.D.**

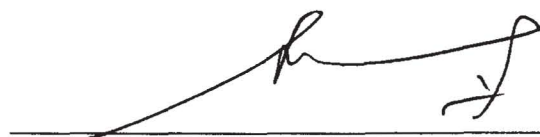
Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

**Ir. Mohd Amin Mohd Soom, Ph.D.**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

**Mohd Zulkifli Mohd Yunus, Ph.D.**

Associate Professor  
Faculty of Civil Engineering  
Universiti Teknologi Malaysia  
(Independent Examiner)



**SHAMSHER MOHAMAD RAMADILI, Ph.D.**

Professor/Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: **13** NOV 2002



This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

**Ir. Radin Umar Radin Sohadi, Ph.D.**

Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Chairman)

**Shattri Mansor, Ph.D.**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia.  
(Member)

**Ir. Mohd Amin Mohd Soom, Ph.D.**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia.  
(Member)



---

**AINI IDERIS, Ph.D.**

Professor/Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date : 9 JAN 2003

## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

---

AHMAD RODZI MAHMUD

Date :

## TABLES OF CONTENTS

	<b>Page</b>
<b>ABSTRACT</b>	iii
<b>ABSTRAK</b>	vi
<b>ACKNOWLEDGEMENTS</b>	ix
<b>APPROVAL</b>	xi
<b>DECLARATION</b>	xiii
<b>LIST OF TABLES</b>	xviii
<b>LIST OF FIGURES</b>	xix
<b>GLOSSARY</b>	xxiii
 <b>CHAPTER</b>	
 <b>I</b> <b>INTRODUCTION</b>	 1
Problem Statement	3
Research Aim and Objectives	6
Scope and Relevance	7
Thesis Outline	8
 <b>II</b> <b>ROAD ACCIDENTS INVESTIGATION AND             DATA ANALYSIS</b>	 10
Importance of Road Accidents Analysis	10
Overview on the Investigation and Analysis	11
Data Analysis	13
Data Analysis Components	15
Analysis of Accident Characteristics	16
Node, Kilometre-Post and Cell Analysis	16
Blackspot	18
Identification of Blackspot	19
Countermeasure	21
Collection of Data from POL27 Form	22
General Information in POL27	23
The Structure of POL27	23
Collision Diagrams	25
Role of Collision Diagram	27
The Creation of Collision Diagram	28
Stick Diagrams	30
Symbol Assignment	34
Symbol Placement	34
Spatial Conflicts in Collision Diagram	35
Geographical Information System	36

	GIS Constraints	38
	Research Focus	42
	Available Road Accident Related Softwares	43
III	CARTOGRAPHIC GENERALISATION AND GEOCOMPUTATION FOR VISUALIZATION	46
	Cartographic Generalization	47
	Geocomputation	49
	Automated Generalisation Issues	50
	GIS and Cartographic Generalisation	52
	The Need for Automated Generalisation	53
	Important of Enhanced Visualisation	55
	Research Agenda	56
	The Need for Algorithm Development	58
IV	METHODOLOGY	59
	Methodology for the Drawing of Collision Diagrams	59
	Base Map	62
	Data Transformation	63
	Data Structuring	65
	Relevant Items from POL27	68
V	ALGORITHM DEVELOPMENT	72
	The Conceptual Model	72
	General Requirements	73
	Expressing the Knowledge	74
	Sequence of Operations	77
	Algorithm Development Approach	78
	The Fundamental Tasks	78
	Preserving Spatial Relationship	80
	Structuring and Formulation of Rules	82
	Information Needed	83
	Detecting the Conflict	84
	Resolving the Spatial Conflicts	87
	Creating Location Database	91
	Approach Undertaken	94
	Symbolisation of Accident Events	95
	Mathematical Algorithm and Technique Employed	98
	Nearest-Neighbour Method	99
	Definitions and Characteristics	100
	Mathematical Detection of Conflicts	101
	Formula for Distance Calculations	102

	Formulating for Position Verification	106
	Definitions and Characteristics	106
	Mathematical Calculations	107
	Algorithm Source Code	111
	Conclusion	114
VI	RESULTS AND ANALYSIS	115
	Data Classification for Testing	115
	Results from the Conceptual Data Set	116
	Location Analysis	116
	Displacement Analysis	121
	Shape Analysis	123
	Adapting Symbols and Data Transformation	124
	Results from the Real Data Set	126
	Achievement of the Technique Employed	131
	Comparisons of Techniques	131
VII	DISCUSSION	134
	Validation of the Algorithm	134
	Issues on Data Gathering	136
	Suitability of Data Structure	136
	Comprehensiveness of Data Structure	137
	Techniques Employed	138
	Displacement Analysis	140
	Effectiveness of the Algorithm	144
	Comparisons with Other Technique	145
	Selection of Base Algorithm	146
	Validity of the Approach	147
	Contribution to Knowledge	148
	Evaluation	149
	Comparison of the Approaches	150
	Comparison of the Output	151
	System Capabilities	157
	User Perception	158
	Output Compatibility	160
VIII	CONCLUSIONS	163
	Summary	163
	Issues Arising From This Study	164
	Benefits of the Study	166
	Suggestions for Future Work	166

REFERENCES	170
APPENDICES	183
A1 A Sample of the POL27 Form (Pin. 1/91) Section A-D : The main information	183
A2 A Sample of the POL27 Form (Pin. 1/91) Section E-F : Information Vehicle and Driver Involved	184
A3 A Sample of the POL27 Form (Pin. 1/91) Section G-H : Information Passenger and Pedestrian Involved	185
A4 A Sample of the POL27 Form (Pin. 1/91) Police description and Sketches of Accident location	186
B Road Accident Distribution along Federal Road Displayed based in KM Post using GIS Software	187
C Proposed Symbol Coding for Accident Types (Ramlah; 1994 )	188
D Samples of Road Accident Database transferred from POL27 to GIS Database System in the Form of Relational Database Format	189
E A Sample of the MAAP Format File	190
F A Sample of the Restructured Tabular Database	191
G Main Menu for the Automation of the Generalization Process	192
VITA	193



## **LIST OF TABLES**

<b>Table</b>		<b>Page</b>
1	Categories of Information in the POL27 form	24
2	A Sample of Stick Diagram generated from MAAP (Adapted from: Radin, 1993)	29
3	Database Structure for the Creation of Collision Diagram	65
4.	Details from Item 18, Item 33 and Item 46 of POL27	68
5	Items under Section D of the POL27 Form (Location Information)	69
6	Items under Section H (Additional Information)	70
7	Evaluating Displacement of Point $P_1$ to $P_2$ and $P_3$	111
8.	Comparison on the capabilities of the Collision Softwares	157

## **LIST OF FIGURES**

<b>Figure</b>	<b>Page</b>
2.1 Phases of Common Traffic Accident Analysis	14
2.2 Coding for Accident location (Ahmad Rodzi, 1998)	17
2.3 A Hand-Drawn Collision Diagram (Source: Radin Umar, 1998)	21
2.4 A Collision Diagram Drawn with a CAD Package (Source: Radin, 1993)	26
2.5 A Collision Diagram from Malaysia (Source: RSRC 1999)	32
2.6 A Collision Diagram from the United Kingdom (Source: TRL 1991)	33
2.7 A Collision Diagram from India (Reddi, 1993)	33
2.8 A Collision Diagram from Korea (Source: TRL 1991)	34
4.1 Methodology for the Creation of Collision Diagrams	60
4.2 Data Processing: Translation and Cartographic Generalisation	64
4.3 Organization of Restructured Data Sources	67
5.1 General Procedures for Re-positioning Symbols	76
5.2 Sequence of Operations	77
5.3 Relationship of Spatial Objects	80
5.4 Information Required for Collision Diagram	83
5.5 Conceptual Method to Detect Conflict by Using Squares	85
5.6 Conceptual Method to Detect Conflict by Using Circles	87
5.7 Approaches to Generate Collision Diagrams with No Spatial Conflict	88



5.8	Example of Traffic Flow Path for Events Placement	92
5.9	Web Style Definition for Symbol Placements	93
5.10	Defining a Polygon in the Web-Style Method at a T-Junction	93
5.11	Extracting Symbols Placement by using an Overlaying Mesh	94
5.12	Derivation of Symbols from the Assortment of Items Recorded in the POL27 Form	96
5.13	A Sample of the Designed Accident Symbols	97
5.14	Defining Points for Nearest-Neighbour Distances	100
5.15	Moving Event $B_n$ to Position $C_n$ with Respect to Event A; where $(n = 1, 2, \dots, n)$	104
5.16	Points Moved to the Nearest Allowable Locations in the Opposite Direction	106
5.17	Displacement verification of P	108
5.18	Evaluating Displacement of Point $P_1$ with Reference to Multiple Segments of J-K-L-M-N	110
5.19	Part of the Source Code for the Spatial Conflict	112
5.20	Part of the Source Code for the Displacement Operation	113
6.1	A Data Set of 10 Circles (Double Overlapping)	117
6.2	Conflict Circles Resolved (Moved to Free Overlapping Zone)	117
6.3	Data Set of 20 Circles (Double, Triple and Quadruple Conflicts)	118
6.4	Conflict Resolved (20 Circles)	118
6.5	Data Set of 40 Points (Ring of Conflicting Circles)	119
6.6	Conflict Resolved (40 Circles)	119

6.7	Data set of 60 circles	120
6.8	Conflicts Resolved (60 Points)	121
6.9	Traces of Circle Displacement	122
6.10	Comparison of shape after resolving the conflicts	123
6.11	A Set of Symbols with Spatial Conflicts	125
6.12	Spatial Conflict Resolved Shown by Appropriate Symbols	125
6.13	A Manually Drawn Collision Diagram on Jalan Sg. Petani	126
6.14	Symbols Enclosed by Circles to Show the Presence of Spatial Conflicts	127
6.15	A Collision Diagram with Spatial Conflict Removed (Jalan Sg. Petani)	128
6.16	Collision Diagram with Spatial Conflicts on Pesiaran Kuala Selangor	129
6.17	A Collision Diagram with Spatial Conflict Removed (Pesiaran Kuala Selangor)	130
7.1	Label Placement Method by Maximizing Rectangles in Limited Spaces (Agarwal et al., 1997)	139
7.2	Label Placement Method Based in Systematically Arranged Circles (Strijk and Wolff, 1999)	140
7.3	Displacement of Symbols in the Removal of the Spatial Conflict	141
7.4	Number of Iterations in the Removal of Spatial Conflicts	142
7.5	Total Distance Displacement versus Number of Symbols	143
7.6	Undisturbed Number of Symbols versus Number of Symbols	145
7.7	A Collision Diagram Plotted by Traffic Engineers's Toolbox (TET)	153

7.8	A Collision Diagram Plotted by Reconstructionist (Jones & Associate's)	154
7.9	A Collision Diagram Plotted by AIS (Collision Diagrammer)	155
7.10	A Collision Diagram Plotted by the Department of Transport, North Carolina	156
7.11	A Collision Diagram Plotted by Intersection Magic (Pd. Programming)	156
7.12	A Collision Diagram Readable in GIS (ArcView) for Further Analysis	161

## GLOSSARY

Aerial Photos	Photograph taken from Aerial Camera, a form of remote sensing equipment to capture image of the earth features
Algorithm	A logical step-by-step procedures in programming tasks
AutoCAD	A computer aided drafting software by AutoDESK
Blackspot	A location considered as prone to road accident
Boolean	A special logic of great utility in computer data processing, based on <i>and/or</i> operators and <i>true/false</i> values
Collision Diagram	A map of a accident blockspot showing the approximate positions and manoeuvres of the vehicles involved
Data Structure	A way of organizing information
DXF	An AutoCad data exchange file
Entities	Things in real world
Fatal	At least one person was killed or died within 30 days
Geocomputation	Geometrical computation to address spatial analysis problem, knowledge construction and data mining in geography. Aims to enrich geographic with a toolbox of methods and model
Generalization	A cartographic process in eliminating visual complexity of maps
GIS	Geographic Information System
Head-on	Crash type involving vehicles from adjacent approaches at an intersection or mid-block
Knowledge Discovery	To provide some means of exploratory data pattern

MAAP	Micro Analysis Accident Package
Manoeuvring	Vehicles movement such as making U turns, reversing, emerging from a driveway/laneway/footpath/median, etc.
Mosaic	A set of aerial photographs being assembled to form a photomap
Near intersection	Less than 10 m from intersection but not within intersection
Objects	Classified items in the geographic database
Pedestrian	Person other than a driver, passenger, cyclist or motorcyclist
Photogrammetry	The science of making measurements on photographs
Relational	A type of structure of a database storage which consist of rows and columns
Database Representation	A set of conventions about how to describe a set of things (geographic features)
RSRC	Road Safety Research Centre, Universiti Putra Malaysia
RUM	Road User Movement
Spatial Conflict	Symbols drawn overlapping on each other that is useless for visual analysis
Topology	Properties of geometrical figures that are invariant under continuous deformation (adjacency, containment, overlap)
Visualisation	Spatialised representations of non-geographic phenomena.